#### PLATE 2 of 3 Utah Geological Survey Geologic Map 180 Geologic Map of the Moab and eastern part of the San Rafael Desert 30'x60' Quadrangles, Grand and Emery Counties, Utah. and Mesa County, Colorado UTAH GEOLOGICAL SURVEY a division of the UTAH DEPARTMENT OF NATURAL RESOURCES in cooperation with the

# No. 1434-98-HOAG-2067

**DESCRIPTION OF GEOLOGIC UNITS** 

U. S. GEOLOGICAL SURVEY

COGEOMAP Agreement

No. 1434-92-A-1087

STATEMAP Agreement

**Quaternary Deposits** Artificial fill -- Clay- to boulder-size material in tailings, railroad and road fill, and dams that are large enough to map at the 1:100,000 scale: locally as much as 21 meters (70 ft) thick; late

Holocene. tream alluvium -- Sand, silt, clay, granules, pebbles, and sparse cobbles adjacent to more active stream courses: unconsolidated, poorly to well-sorted channel-fill and low terrace deposits; thickness varies widely, but commonly less than 10 meters (33 ft) thick; Holocene to late Pleistocene.

Alluvial mud -- Light- to medium-gray silt, clay, sand, and minor fragments o andstone, mostly derived from nembers of the Cretaceous Mancos Shale; unconsolidated; fills swales in the softest parts of the Mancos Shale; thickness less than 10 meters (33 ft); Holocene to late Pleistocene Pediment-mantle deposits -- Poorly to moderately sorted, rounded to angular boulders, cobbles, pebbles, granules sand, silt, and clay; cover bedrock

surfaces between drainages as much as 120 meters (400 ft) above local base level; commonly less than 30 meters (100 ft) thick; mostly late Pleistocene. Alluvial-fan deposits -- Poorly sorted, angular to subrounded gravel. containing cobbles and sparse boulders, in crudely bedded to unstratified granules, sand, silt, and clay matrix: cut-and-fill channel features locally present: deposited at the foot of mountains, cliffs, and at the mouths of streams: thickness commonly less than 15 meters (50 ft): Holocene to late

Ferrace deposits -- Cobbles, granules, pebbles, sand, silt, and clay adjacent to, but higher than, river, stream, and larger ephemeral stream courses; locally as high as 200 meters (650 ft) above present stream courses; generally contain clasts from distant upstream sources (metamorphic, igneous, and chert clasts); thickness mostly 5 meters (16 ft) or less, but may be 20 meters (60 ft) or more in salt valleys; late to middle Pleistocene. Alluvial gravel, undifferentiated -- Clast sizes vary from deposit to deposit; no

particular geomorphic form or location; thickness commonly 5 meters (16 ft) Basin-fill alluvium -- Sand, silt, clay, granules, pebbles, and cobbles; may ontain local lacustrine or eolian deposits: fills depressions created by salt dissolution in Pennsylvanian Paradox Formation: may be as much s 180 meters (600 ft) thick: mostly

Pleistocene in age, commonly covered by Holocene unconsolidated deposits. Γufa deposits -- Mostly drab, lightvellow-gray, calcareous tufa, some yellow ocher to dusky red brown, porous, crudely laminated, locally thin bedded: weathers in plates and platelets formed by cold-water springs and geysers; thickness as much as 7.5 meters (25 ft); Holocene to middle

Mixed eolian and alluvial deposits -- Sand and silt of eolian origin interspersed with silt, sand, and gravel of fluvial origin; generally dominated by eolian deposits; commonly displays a well developed caliche soil horizon at the top: thickness 10 meters (33 ft) or less: Holocene to middle Pleistocene. Eolian deposits -- Well-sorted sand and silt: deposited in sheets (Oes) and dune (Oed): commonly fills hollows in sand stone outcrops or collects on the lee

sides of cliffs and slopes; thickness 15 meters (50 ft) or less; mostly Holocene. Glacial till -- Very poorly sorted, angular to subangular clasts of all sizes: larger clasts are commonly striated: fills U shaped canvons in the La Sal Mountains: as much as 90 meters (300 ft) thick in lateral moraines; early Holocene to late Pleistocene. Falus and colluvium -- Rock-fall blocks. boulders, smaller angular gravel, sand, and silt; deposited on slopes below

cliffs and steep slopes; only larger deposits mapped; thickness generally .5 meters (15 ft) or less; Holocene to late Pleistocene. Slumps and slides -- Coherent to broken and jumbled masses of bedrock that have moved downslope due to gravity; Jurassic Brushy Basin Member of the Morrison Formation; varied

thicknesses; Holocene to late Bouldery colluvium -- Large angular blocks covering slopes in La Sal Mountains: broken by freeze and thay of hard rock units; may be as thick as

30 meters (100 ft); Holocene to late Quaternary deposits, undivided (shown on cross sections only) -- Mostly basinfill deposits (Oab); Holocene and

# **Quaternary-Tertiary Deposits**

Older alluvial-fan deposits -- Sand, silt, granules, pebbles, cobbles, and sparse boulders deposited at the foot of the La Sal Mountains; thickness 60 to 90 meters (200-300 ft); early Pleistocene to Pliocene(?).

### **Tertiary Rocks**

Geyser Creek Fanglomerate -- Yellowbrown, light-brown, and light-gray conglomerate, sandstone, and siltstone derived from the La Sal Mountains generally poorly sorted and weakly cemented with calcium carbonate thickness as much as 305 meters (1,000 ft), but exposures are generally less than 92 meters (300 ft) thick;

La Sal Mountains intrusive rocks -Hornblende-plagioclase trachyte,

quartz-plagioclase trachyte, peralkaline trachyte peralkaline rhyolite and nosean trachyte; all porphyritic with fine-grained to aphanitic ground mass (Ross, unpublished data, see 13 and 14): intruded at shallow depths as laccoliths, plugs, sills, and dikes; includes breccia pipes; emplaced 25 to 28 million years ago (Oligocene).

#### **Cretaceous Rocks**

Farrer Formation -- Interbedded light- to dark-brown, medium-grained, thin- to thick-bedded sandstone and pale-gray. green-gray, and brown mudstone and siltstone: ledge and slope former: lower contact gradational, placed above highest carbonaceous beds in the Neslen Formation: only lower part preserved in the quadrangle: 70 to 204 meters

(230-670 ft) thick; Campanian. Veslen Formation -- Interbedded lightto dark-gray mudstone, carbonaceous shale, and coal and light- to dark-brown sandstone; slope-former with sporadic prominent ledges; coal beds generally less than 0.6 meters (2 ft) thick; lower contact at top of Sego Sandstone cliff: about 43 meters (140 ft) thick;

Sego Sandstone -- Light-gray and yellowgray sandstone and gray mudstone; ndstone is fine to medium grained, massive, and cliff-forming; mudstone is slope-forming; displays hummocky bedding, cross-bedding, convolute bedding, ripple laminations, and bioturbation; contains trace fossils contact with Buck Tongue of Mancos Shale is gradational, placed at the base of the first medium-bedded sandstone bed; about 40 meters (130 ft) thick;

Mesaverde Group (shown on cross sections only) -- Includes Farrer. Neslen, and Sego Formations: does not include lower Mesaverde tongue of Castlegate and Blackhawk Formations.

Buck Tongue of Mancos Shale --Medium- to dark-gray marine mudstone or shale: forms badland slopes: contains thin, fine-grained sandstone beds at top: distinct contact with Castlegate Sandstone below; 37 to 73 meters (120 240 ft) thick, thinning westward; Campanian. Castlegate Sandstone -- Pale yellow-

orange and light-gray, cross-bedded ndstone interbedded with minor mudstone, carbonaceous shale, and coal; sandstone is fine grained, generally thick bedded to massive, and cliff and bench forming; locally bioturbated, contains trace fossils; lower contact generally placed above highest carbonaceous shale bed in the underlying Blackhawk Formation; 18 to 30 meters (60-100 ft) thick, thinning eastward; Campanian.

Blackhawk Formation -- Pale yellow orange to light-brown sandstone interbedded with mudstone, carbonaceous shale, and coal; sandstone is very fine grained, generally thick bedded, and cliff forming; lenticular coal beds less than 30 centimeters ( ft) thick; locally intensely bioturbated, contains trace fossils, leaf imprints, and rare shark teeth; gradational with the upper (Blue Gate) shale member of the Mancos Shale, contact is placed at the base of the first thick or medium bed of sandstone; 9 to 40 meters (30-130 ft) thick, thinning eastward; Campanian. Joner shale (Blue Gate) member of Mancos Shale -- Mostly light- to darkgray marine thinly laminated to thin-

bedded, slope-forming shale, mudstone, and siltstone interhedded with subordinate vellow-brown to vellow gray, mostly very fine- to fine-grained calcareous sandstone that crops out in several thin mappable (Kms) zones of subtle ledges and cliffs: the middle more sandy part of the upper shale member that contains most of the ledge is the Prairie Canyon Member of Cole and others (1997): zone of thin-bedded fine-grained sandstone at top: lower contact with Ferron Sandstone Member is gradational: about 1.020 meters (3,350 ft) thick; Campanian to Formation overlain by red beds; 2 to 67 meters (6-220 ft) thick (see figure

Ferron Sandstone Member of Mancos Shale -- Brown-gray to yellow-gray, marine, fine-grained sandstone, sandy mudstone, and carbonaceous shale; fissile to thin bedded; generally forms two sandstone cuestas with a slope of dark-gray to black carbonaceous shale between them; locally fossiliferous; lower contact is a subtle scour surface locally overlain by lenticular lag deposits of pebbly, medium- to coarsegrained sandstone; 15 to 40 meters (50-

thicker to west; Turonian to

30 ft) thick; Turonian. Tununk Shale Member of Mancos Shale -- Light- to dark-gray, marine shale or mudstone; contains fine-grained sandy zones, especially near the top; slope forming; locally contains concretion Coon Springs Bed in the upper third of the unit; lower contact with Dakota is abrupt but conformable. The lower contact is an unconformity where the Dakota is missing (Western exposures) and marked by change from green (Cedar City Fm.) to gray shale; 45 to 120 meters (145-390 ft) thick, generally

Mancos Shale and other formations, undivided-- On cross sections, includes Buck Tongue of Mancos, Castlegate Sandstone, Blackhawk Formation, upper shale (Blue Gate) member, Ferron Sandstone Member, and Tununk Shale Member of Mancos Shale, as well as Dakota Sandstone. On map in Salt Valley area, includes lower part of upper shale, Ferron, and Tununk Dakota Sandstone -- Yellow-gray to

brown sandstone, conglomeratic sandstone, and conglomerate interbedded with grav mudstone. carbonaceous shale, coal, and claystone commonly forms cliffs and ledges: commonly divisible in the east part of the quadrangle into upper and lower cliff-forming sandstone and conglomerate and a middle, slopeforming mudstone unit; scoured into the Cedar Mountain or Burro Canvon Formations: 0 to 37 meters (0-120 ft) thick, discontinuous in west part of quadrangle, thickens eastward:

Dakota Sandstone and Cedar Mountain Formation, undivided -- Mapped in areas where they are too thin or where they are too difficult to separate

Dakota Sandstone and Burro Canyon Formation, undivided -- Mapped in areas where they are too thin or where they are too difficult to separate Cedar Mountain Formation -- Drab olivegreen to variegated mudstone and brown to gray sandstone, gritstone, conglomerate, and limestone; mudstone

is slope forming, other rock types form

ledges; locally contains petrified wood;

lower contact (unconformity) is placed at base of a prominent sandstone or onglomerate ledge or cliff above the brighter variegated mudstone of the Brushy Basin Member of the Morrison Formation; correlative with the Burro Canyon Formation; 12 to 76 meters (40-250 ft) thick, thins irregularly

eastward; Albian. Burro Canvon Formation -- Brown to gray sandstone, gritstone, conglomerate. and limestone and olive-green to gray mudstone: mostly cliff forming: correlative with Cedar Mountain Formation; exposed southeast of the Colorado and Dolores Rivers: lower contact (unconformity) is abrupt and placed at base of a conglomeratic sandstone above the slope-forming mudstone of the Brushy Basin Member of the Morrison Formation: 0 to 60 meters (0-200 ft) thick: Albian.

# Cretaceous-Jurassic Rocks

Cedar Mountain/Burro Canvon and Morrison Formations, undivided (shown on cross sections only).

#### Jurassic Rocks

Brushy Basin Member of Morrison Formation -- Variegated (purple, green, white, orange) mudstone interbedded with gray, white, or brown conglomeratic sandstone, conglomerate, nodular limestone, and gritstone; slope forming with subtle ledges; purple and lavender hues dominate in most areas, but bright green dominates in Cache Valley and in the southern part of the Salt Valley anticline; layers of bentonitic claystone are common, outcrops are generally prone to slumping; lower contact placed at the base of the mudstone sequence or at the base of the lowest conglomerate ledge; 90 to 135 meters (295-450 ft) thick; Upper Jurassic.

Pipiringos and O'Sullivan (1978): 8 to Salt Wash Member of Morrison 72 meters (25-235 ft) thick, generally Formation -- Light-yellow-gray thinning eastward: Middle Jurassic sandstone interbedded with red and Upper Carmel Formation -- Western gray mudstone and siltstone; sandstone correlative of the upper half of the is fine to coarse grained, cross-bedded, Dewey Bridge Member: mostly and forms medium to thick lenses: medium- to red-brown, fine-grained mudstone and siltstone form slopes or sandstone, with interbedded ledges of recesses between sandstone ledges; light-vellow sandstone and subordinate lower contact at base of first thick conglomerate and finely laminated. sandstone bed above the red or lavende chippy-weathering calcareous siltstone: siltstone of the Tidwell Member of the red-brown sandstones display indistinct Morrison Formation; locally intertongues with Tidwell siltstones bedding identical with that in the upper half of the Dewey Bridge Member: 40 to 90 meters (130-300 ft) thick; mapped as the upper Carmel Formation where chippy-weathering calcareous Fidwell Member of Morrison Formation siltstones appear: lower contact is at and Summerville Formation, undivided the top of a distinctive white-weathering

- Divisible in field, but too thin to map eparately at the 1:100,000 scale. Tidwell Member (Jmt) consists of calcareous, thin-bedded lavender maroon, and light-gray siltstone, lightgray, thin- to thick-bedded, very finegrained sandstone, and gray thin-bedded or nodular limestone; all slope forming; limestone locally contains large white chert concretions; west of 110° W... locally intertongues with thick white gypsum bodies; 6 to 20 meters (20-65 t) thick. Summerville unconformably (J-5 unconformity) overlain by Tidwell Member. In areas where combined with the Tidwell, the Summerville is gray, tan, brown, and red, mostly finegrained, thin-bedded sandstone and siltstone that forms a steep slope and becomes ledgy near the top; 2-21 meters (6-69 ft) thick. Upper and Middle

Summerville and Morrison Formations. undivided -- Mapped in areas where Morrison Formation members and the Summerville Formation can't be separated: Upper and Middle Jurassic Summerville Formation -- Mapped separately near the Green River where it is mostly red sandstone and siltstone; 38°45' laminated to medium bedded: mostly forms steep slope with light-brown sandstone ledge at top; gypsum veinlets and thin beds of gypsum in the upper part in T. 22 and 23 S., R. 16 and 17 E.; lower contact gradational with Curtis Formation in far west; lower contact abrupt at base of a reworked zone of the Moab Tongue of the Curtis

, plate 3 for thickness detail); Middle summerville and Curtis Formations, undivided -- Mostly red fine-grained andstone and siltstone; laminated to medium bedded; commonly forms steep slope; only mapped in T. 23 S., R. 17 /2 E. and the southwest corner of T 23 S., R. 18 E.; 30 to 40 meters (100-130 ft) thick; Middle Jurassic Curtis Formation -- Brown, gray, green. lavender, and orange fine-grained sandstone and siltstone; mostly thin bedded, argillaceous and calcareous, forms slopes and ledges; contains red, black, and olive-brown chert near top; unconformable lower contact (J-3 unconformity of Pipiringos and

> thick, thickening westward; Middle Moab Member of Curtis Formation (member of Entrada Sandstone on previous maps) -- Light-yellow-gray. fine- to medium-grained, cross-bedded massive, and cliff-forming sandstone; forms a tongue between the Summerville and Entrada Formations and pinches out in the western part of the quadrangle; rests directly on the Slick Rock Member in the east; the lower contact with the Slick Rock Member of the Entrada Sandstone is placed at the base of a prominent parting or a subtle line, probably the J-3 unconformity of Pipiringos and O'Sullivan (1978), which has considerable relief in the Dewey area; 0 to 42 meters (0-138 ft) thick

O'Sullivan, 1978) with the earthy

member of the Entrada Sandstone or

the Slick Rock Member of the Entrada

Sandstone: 0 to 54 meters (0-177 ft)

(including the main Curtis where both are present); Middle Jurassic. Moab Member of Curtis Formation, Slick Rock Member of Entrada Sandstone, and Dewey Bridge Member of Carmel Formation, undivided-- in areas where they cannot be differentiated. Entrada and Curtis Formations, undivided - Mapped in areas where the Slick Rock Member of the Entrada Sandstone and the Moab Member of the Curtis

Formation were not differentiated in Earthy member of Entrada Sandstone --Earthy red-brown, fine-grained sandstone: thick nodular to indistinct bedding: more resistant than the Curtis Formation above, but less resistant than the Slick Rock Member of the Entrada Sandstone below: lower contact is generally abrupt, placed above the massive, smooth-weathering sandstone of the Slick Rock; present in R. 16 and 17 E.: the outcrop pinches out in section 11. T. 23 S., R. 17 E.: 0 to 18 meters

(0-60 ft) thick: Middle Jurassic.

-- Mostly orange-red or banded orangegenerally capped by white to lavender, red and white sandstone: generally find chippy-weathering, finely laminated grained, eolian cross-bedded; massive calcareous siltstone; mapped where with local discontinuous partings; white to lavender siltstone appears: resistant and smooth weathering, but lower contact placed above upturned not as resistant as the Moah Member edges of Navajo Sandstone cross-bed (I-2 unconformity of Pipiringos and of the Entrada Sandstone: locally pocked with abundant small spherical O'Sullivan, 1978): 24 to 27 meters (80holes (with diameters up to 10 90 ft) thick: Middle Jurassic. centimeters) in outcrop; the lower San Rafael Group, undivided (shown on contact is commonly crenulated or cross sections only) -- Includes contorted above the darker red-brown Summerville and Curtis Formations sandstone of the Dewey Bridge all members of the Entrada Sandstone. Member of the Carmel Formation: 43 and upper and lower members of the

to 152 meters (140-500 ft) thick. thinning eastward; Middle Jurassic. Earthy and Slick Rock Members of Entrada Sandstone, undivided -- North of Tenmile graben and in scattered areas near the Green River where the two members could not be differentiated in

Entrada and Carmel Formations,

undivided -- Mapped in areas where

the Carmel and Entrada Formations

were not differentiated in mapping.

Sandstone on previous maps) -- Upper

half is dark-red, muddy, earthy, fine-

interbedded dark-red, red-brown, light

medium-grained sandstone; upper half

commonly has contorted, nodular, or

indistinct bedding and locally contains

white beds; upper half forms slopes or

recesses between the overlying Slick

Rock Member of the Entrada Sandstone

and the lower half: lower half is more

cherty, and forms scabs on the

resistant, is commonly calcareous and

underlying Navajo Sandstone; yellow-

gray beds in the lower half resemble

are flat bedded: lower half is locally

contact is the J-2 unconformity of

missing, especially in the east; lower

calcareous siltstone in the lower Carmel

Formation: 30 to 37 meters (100-120)

Lower Carmel Formation -- Western

light-brown, mostly fine-grained

correlative of the lower half of the

Dewey Bridge Member; light-gray,

ft) thick: Middle Jurassic.

10 Kilometers

ie underlying Navajo Sandstone, but

grained sandstone: lower half is

brown, and yellow-gray, fine- to

Dewey Bridge Member of Carmel

Formation (member of Entrada

Slick Rock Member of Entrada Sandstone

fine- to medium-grained, eolian crossbedded, massive sandstone; lower third commonly weathers to a cliff, the remainder into domes and rounded knolls; locally contains thin, hard, gray limestone beds (Jnl); lower contact placed at the top of a thick, white to pink sandstone in the Kayenta Form ation; 0 to 225 meters (0-740 ft) thick. pinches out to the northeast over the Incompangre uplift; Lower Jurassic. Kaventa Formation -- Red-brown. lavender-gray, fine- to coarse-grained. medium- to thick-bedded sandstone contains local white and dark-brown beds, intraformational conglomerate and limestone: forms thick ledges: generally contains abundant red slopeorming siltstone in upper third; lower contact is a scoured surface in the massive orange-brown Wingate Sandstone; 30 to 90 meters (100-300) ft) thick; Lower Jurassic. Wingate Sandstone -- Orange-brown,

Carmel Formation.

sandstone, in medium to thick, flat beds:

Navajo Sandstone -- Mostly light-hued,

dark-brown-weathering, fine-grained massive sandstone: forms vertical cliff along canvon walls, commonly stained with desert varnish: abrupt contact with underlying Chinle Formation placed at base of massive, cliff-forming sandstone or on top of thick, orange-brown, flat bedded sandstone (J-0 unconformity) below which typical Chinle slopeforming siltstones and sandstones are found: 75 to 137 meters (250-450 ft) thick: Lower Jurassic. Glen Canyon Group -- Navajo, Kayenta, and Wingate Formations, where exposures cannot be differentiated; combined Navajo, Kayenta, and

# cross sections.

Triassic Rocks Chinle Formation -- Red-brown sandstone, siltstone, conglomeratic sandstone, and mudstone; forms steep slope with Moenkopi Formation below: has basal member of quartzose gritstone or sandstone and mottled siltstone and sandstone beneath an unconformity; contains multiple intraformational unconformities adjacent to salt diapirs;

lower contact is the Te-3 unconformity

Wingate Formations also shown on

of Pipiringos and O'Sullivan (1978) which is slightly angular; 0 to 275 meters (0-900 ft) or more thick, greatest thickness in rim synclines adjacent to salt-cored anticlines and locally missing on anticlines; only 12 to 30 meters (40 100 ft) cover Precambrian rocks on the Uncompange uplift to the northeast;

Upper Triassic. Moenkopi Formation -- Red-orange, chocolate-brown, and medium-brown sandstone, silty sandstone, and minor siltstone and conglomerate; generally divisible into two to four members, but are undivided on the map; lower contact is the Tk-1 unconformity of Pipiringos and O'Sullivan (1978), which is slightly angular and is found at the top of the more red-brown sandstone of the underlying Cutler Formation; total thickness is 0 to 400 meters (0-1,300 ft) or more, thinning regionally eastward and may be missing on the Uncompangre uplift in the northeast and very thick in rim synclines adjacent to salt-cored anticlines: Middle (?) to Lower Triassic. Triassic formations (shown on cross

up to 18 meters (60 ft) of Kaibab

Formation and 130 meters (430 ft) of

White Rim Sandstone that overlie the

Aissourian). sections only) -- Chinle and Moenkopi Formations, undivided. Permian Rocks Cutler Formation -- Interbedded redbrown subarkosic, arkosic, and micaceous sandstone and lavenderbrown conglomerate; sandstone is fine to coarse grained and gritty in eastern exposures; low- to high-angle cross-

beds, thin bedded to massive, and forms smooth and rounded ledges; conglomerate is mostly pebbles to 13centimeter (5-inch) cobbles, but cobbles exceeding 30 centimeters (1 ft) or more in diameter are common in the eastern part of the quadrangle; mostly quartzite, granite, felsite, gneiss, and schist clasts matrix is poorly sorted, fine- to coarsegrained sandstone, with grains of quartz. lithic fragments, mica, feldspar, and unidentified black minerals; laminated to indistinct bedding; weathers to smooth irregular slopes or gentle ledges: lower contact is placed above a gray limestone ledge that contains Late uplift; Middle Pennsylvanian. Pennsylvanian (Virgilian) fusulinida 0 to 2,450 meters (0-8,000 ft) thick; missing over some salt-cored anticlines. thickest at the west edge of the Uncompangre uplift; as much as 1,000 meters (3,300 ft) exposed; 75 meters Leadville Formation (shown on cross (245 ft) of gray-white, cross-bedded

quartzose sandstone at the top of the lolomite: 145 to 180 meters (480-600 Cutler Formation in the north part of ft) thick; not present on Uncompangre the southwest flank of Castle Valley uplift; Mississippian. may be an outcrop of White Rim Devonian-Cambrian formations (shown Sandstone; Lower Permian. on cross sections only) Permian formations (shown on cross sections only) -- Cutler Formation and

∟<sub>38°45'</sub> 38°45'−

Cutler Formation in subsurface in the west part of the quadrangle; both pinch out to the east.

#### Pennsylvanian Rocks Honaker Trail Formation and Paradox Formation undifferentiated (mapped

as dikes, sills, or plugs in Lower Proterozoic rocks so age relative to only in Salt Valley). other Middle Proterozoic rocks is Honaker Trail Formation -- Interbedded uncertain; Middle Proterozoic. sandstone, siltstone, limestone, and Aplite and pegmatite -- Aplite - Overall subarkosic sandstone; limestone is fine-grained, non-foliated granitic rock commonly fossiliferous; the lower with varying amounts of quartz, Kcontact is not exposed, but the unit is feldspar, and plagioclase; forms pink juxtaposed against Paradox Formation to red fractured outcrops locally cut by caprock on the southwest flank of the quartz veins and pegmatite dikes. Onion Creek salt-cored anticline; 0 to Pegmatite - Shown near Coates Creek: 1,525 meters (0-5,000 ft) or more thick, thickening eastward to the west edge medium- to coarse-grained, pink to white rock with varying amounts of of the Uncompangre uplift, missing on quartz, K-feldspar, plagioclase, biotite. the Uncompangre uplift and over some and muscovite. Both Middle salt-cored anticlines; maximum surface thickness is less than 300 meters (985 ft); Upper Pennsylvanian (Virgilian-

Proterozoic. Granite -- Coarse-grained, porphyritic, generally non-foliated rock containing subequal amounts of quartz, K-feldspar, Paradox Formation caprock -- Mostly and plagioclase, with minor hornblende, light-gray, contorted gypsum with biotite, and opaque minerals; mostly erlayered black and gray shale, thin granite in composition, but includes chippy limestone, and sandstone; locally exposed in salt valleys and along some quartz monzonite and granodiorite; contains large pink Ksalt-dissolution deformed bedrock; feldspar crystals generally up to 8 caprock is the residue after salt is centimeters (3 inches) in diameter; dissolved from the Paradox Formation; forms gray to pink-gray bouldery up to 200 meters (650 ft) exposed and outcrops cut by pegmatite, aplite, and may reach a total of 350 meters (1,150 ft) in the subsurface. Paradox Formation (shown on cross

sections only) -- Interbedded evaporite, clastic, and carbonate rocks; evaporites include finely laminated halite, sylvite. carnallite, and anhydrite and may constitute as much as 85 percent of the formation; clastic and carbonate rocks are interbedded shale, siltstone. limestone, and dolomite and are rouped into "marker beds" (Hite (77): includes Pinkerton Trail and Molas Formations (see lithologic column): 0 to 1.370 meters (0-4.500 ft) thick in Paradox basin, but as much as 4.300 meters (14.100 ft) thick in saltcored anticlines, salt commonly missing adjacent to salt-cored anticlines. Proterozoic. formation missing on Uncompangre

109°45'

# Lower Paleozoic Rocks

110°00'

Grand Co

San Juan Co

sections only) -- Limestone and

forms dark-gray to black, bouldery outcrops; Lower Proterozoic. Amphibole gneiss -- Hornblendeplagioclase gneiss with minor quartz, piotite, and K-feldspar; locally interlayered with thin bands of metaguartzite; fine to medium grained and generally strongly foliated and lineated; gneiss forms small, nonresistant black outcrops with local quartzite ledges; Lower Proterozoic elsic gneiss -- Quartz-K-feldsparplagioclase gneiss with about 5 to 15 percent biotite; overall granitic composition, but locally variable medium grained with strong foliation and lineation defined by preferred orientation of biotite; gneiss forms pinkgray to purple-red outcrops locally cut y dikes of pegmatite, aplite, and quartz; Lower Proterozoic Precambrian rocks (shown on cross sections only) -- Basement rocks.

Ouaternary

Tertiary

Cretaceous

Oligocene

Cretaceous

and segregations, and locally intruded

granodiorite and quartz diorite gneiss

by variably deformed dikes of

quartz dikes and veins; Middle Biotite granodiorite -- Gray to pink, fineto medium-grained; composed of various amounts of plagioclase, Kfeldspar, quartz, and biotite; age relative to granite (Yg) uncertain; Middle Diorite, gabbro, and quartz diorite --

**Precambrian Rocks** 

Quartz pegmatite -- Mostly fine- to

coarse-grained quartz with feldspar;

amprophyre -- Composed of amphibole,

biotite, feldspar, and quartz; exposed

Coarse-grained plutonic rock containing abundant plagioclase and hornblende, with lesser amounts of pyroxene, biotite and quartz; varies from nonfoliated to moderately foliated along pluton margins that also contain deformed inclusions of wall rock; forms black to brown knobby outcrops; Lower Granodiorite and quartz diorite gneiss -

- Quartz-plagioclase, with or without K-feldspar, gneiss with about 10 to 20 percent hornblende plus biotite: medium to coarse grained with weak to strong foliation; larger bodies form black to dark-gray bouldery outcrops; also occurs as smaller unmapped dikes in the biotite gneiss; Lower Proterozoic. Biotite gneiss, gneiss, and schist --Contain varying proportions of quartz, lagioclase, and K-feldspar, with about 10 to 30 percent biotite and minor muscovite, hornblende, garnet, and rare sillimanite; generally fine grained, well

foliated, thinly layered, and openly to

with medium-grained granitic dikelets

109°30'

10 Miles

isoclinally folded; locally migmatitic

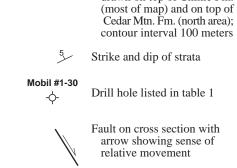
#### **GEOLOGIC SYMBOLS** CONTACT -- Includes contacts approximately located or inferred FAULT -- Dashed where approximately located; dotted where concealed. Bar and ball on down-thrown

ANTICLINE -- Arrow shows plunge direction

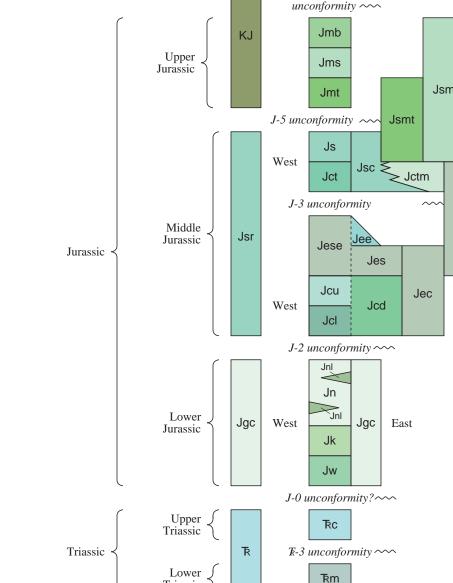
109°15'

SYNCLINE -- Arrow shows plunge direction → MONOCLINE -- Arrow shows plunge direction; T24S, STRUCTURAL CONTOURdrawn on top of Chinle Fm. (most of map) and on top of Cedar Mtn. Fm. (north area): contour interval 100 meters Strike and dip of strata Drill hole listed in table 1

# Fault on cross section with



109°00'



**CORRELATION OF GEOLOGIC UNITS** (see description on plate 2)

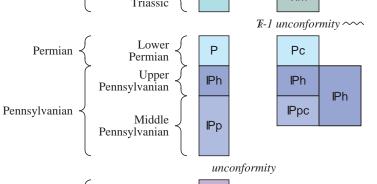
unconformity

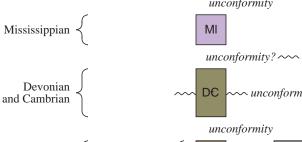
Ks

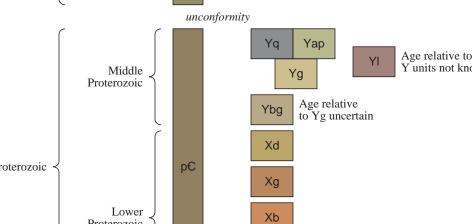
Kmb

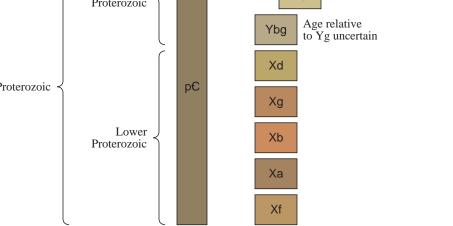
Kmu

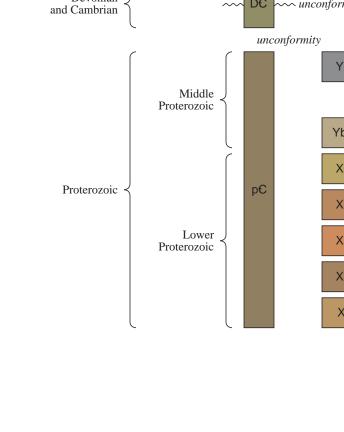
unconformity -

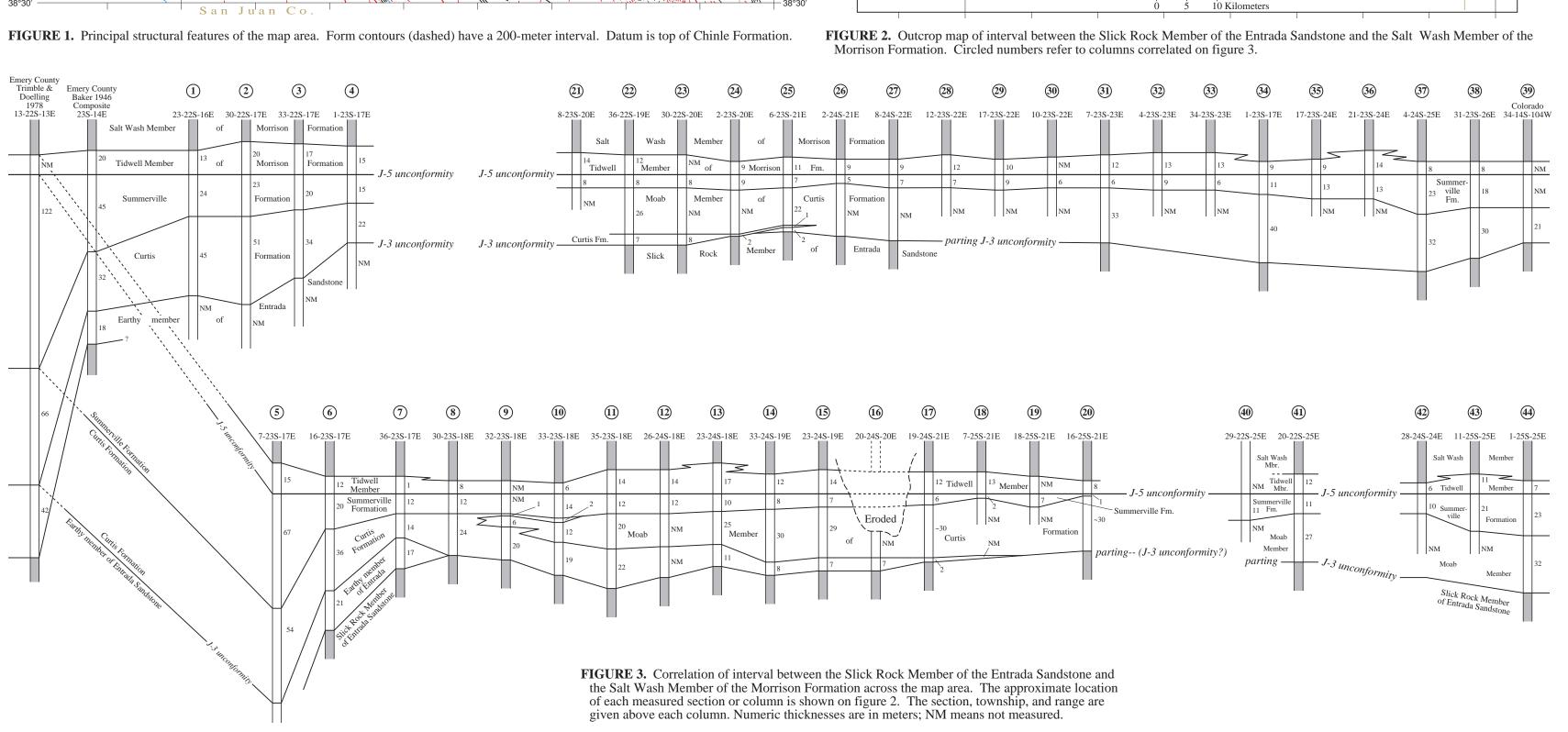












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